

Reef Check Australia

Heron Island Reef Health Report 2020



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This report should be cited as: J. Salmond, J. Schubert and C. Roelfsema.
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Image from Jodi Salmond
Front Cover Image from Jordan Ivey



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1.0 PROJECT INTRODUCTION

Reef Check Australia's (RCA) monitoring program is a peer-reviewed, volunteer reef health monitoring program that trains volunteers to collect data on reef composition, abundance of indicator organisms (invertebrates and fish) and reef health impacts, using a globally standardized protocol (Done et al., 2017, Hill and Wilkinson, 2004).

RCA monitoring sites were established on Heron Island in 2011, when RCA was invited to collaborate by the University of Queensland's Remote Sensing Research Centre (RSRC). The RSRC team has been cataloging the benthic composition of Heron Reef annually since 2001 via geo-referenced photo transects (Roelfsema et al 2010, Roelfsema et al 2021). This and other field data, in combination with satellite imagery, is used to create and validate benthic habitat maps (Roelfsema et al 2018). RCA survey data augments this substantial spatial dataset by offering further information on impact severity and abundance of key organisms, as well as allowing field-based comparisons of benthic composition.

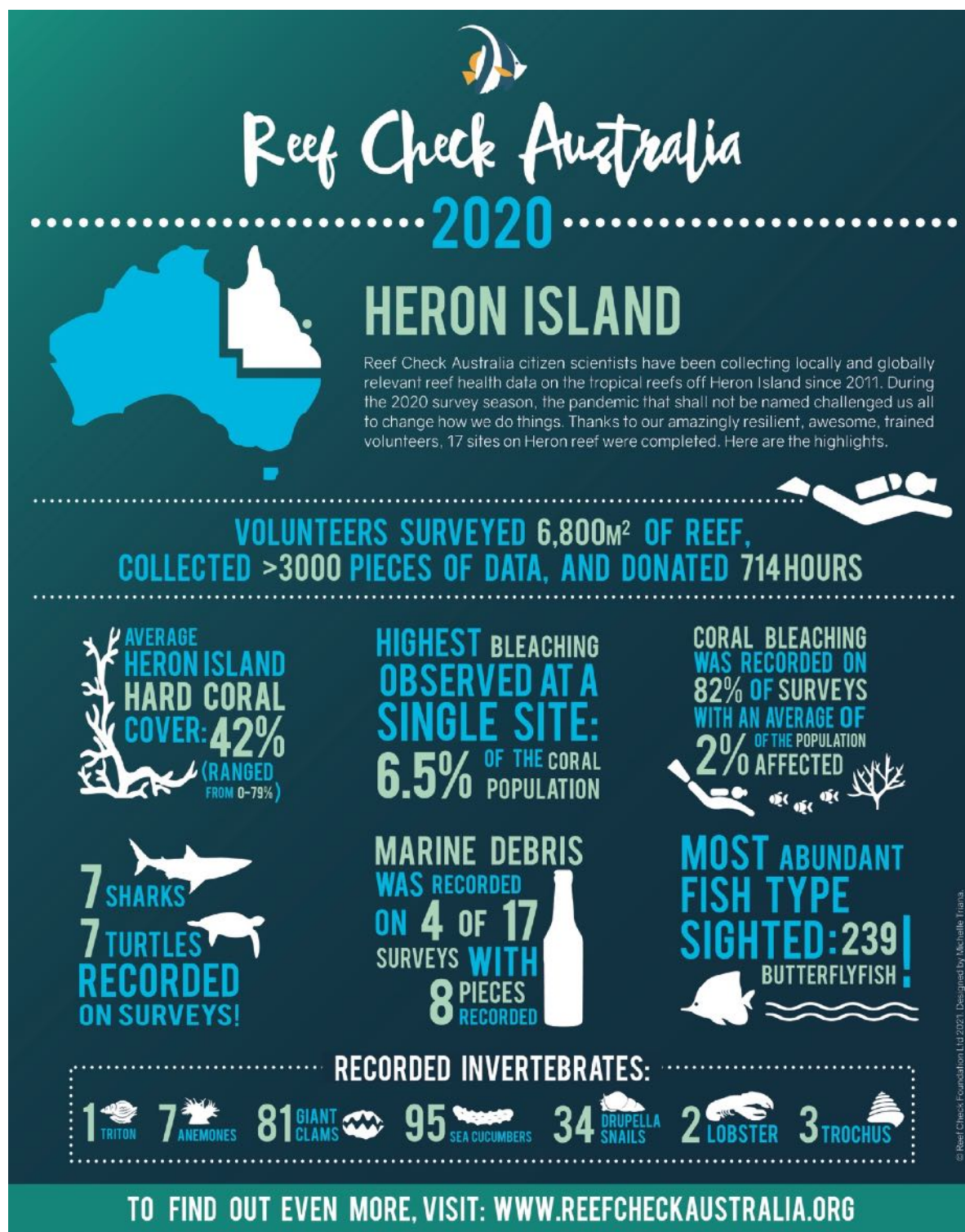
Even though Heron's reefs are intensely studied, with hundreds of researchers visiting the University of Queensland's Research Station annually, there are limited programs that consistently document long-term reef health. Hence the RSRC and RCA initiative can offer a valuable perspective on these reefs, combining a variety of techniques for long-term, cohesive studies. Since the RCA Heron Reef program started in 2011 in partnership with the University of Queensland's RSRC, additional sites have been added to allow for a more representative collection of survey locations around the island. A total of 17 RCA Heron Reef Sites are now monitored as part of the long-term monitoring program.

Reef Check Australia's survey teams monitored all 17 of these sites (ten reef slope sites and seven reef flat sites) around Heron Reef in 2020. Substrate line transects, in addition to invertebrate and impact belt transects, were conducted at each site. Fish surveys were completed at all 17 sites in 2020. Underwater cameras were used to document visual evidence of key site features, reef impacts and invertebrates. Summary findings for the 17 surveys conducted around Heron Island are presented in this report.

This project demonstrates the value of collaborative citizen-science initiatives as a powerful tool to contribute useful information for science, management and education initiatives. It is intended to continue the long-term monitoring program at Heron Island. This will provide important information in regards to the Health Status of the reef for Marine Park Managers, Island managers, researchers and resource users (including staff and guests), and the broader community.

The Heron Reef RCA dataset has been used as annual supplementary marine condition information for the Fitzroy Basin Report Card by the Fitzroy Partnership for River Health (<https://riverhealth.org.au/>). Environmental report cards are designed to distil complex scientific knowledge, and through long-term monitoring, determine status and trend of catchment and marine health. Additionally, the percent cover of hard and soft coral averaged across monitoring sites for each year has been scored using Reef Plan Reporting standardised scales, which provides regionally relevant reef health information for the Reef Plan Marine Monitoring Program (<https://eatlas.org.au/>).

2.0 SUMMARY OF FINDINGS



Heron surveys for 2020 were made possible from the generous support from:



and the assistance from each of our volunteer participants.

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2.1 Key findings from the 2020 surveys:

- Total average hard coral cover across all sites was 42%; this is consistent with previous years and similar to 2018, 42%; 2016, 40% and 2015, 40% results. Hard coral cover ranged from zero percent (at Stevos Carbonara) to 79% at Blue Pools. Nine sites had coral cover greater than 50%, two sites had between 25-50% cover and six sites had less than 25% coral cover.
- Most sites had low or zero levels of soft coral (present at eight of 17 sites and averaging 4% coverage).
- No Crown of Thorns starfish were observed, which is a decrease from 2019.
- Indicator sea cucumbers were recorded in higher abundances on sandy inshore reef flat sites. Six snorkel sites had sea cucumbers, whilst only five of the dive sites had sea cucumbers present.
- Giant clams were recorded on all but one site (Coral Grotto). White Wedding and Heron Bommie had the highest abundance with 23 and 13 counts recorded respectively per 400m².
- Coral scarring from unknown causes was reported at all of the 17 sites, with the highest record of 34 counts per 400m² at Last Resort, an inshore sandy reef flat. An average of 7.3 counts per 400m² were recorded for all sites.
- Debris was recorded at only four sites; Coral Cascade had three pieces of general trash; Canyons and Heron Bommie had two pieces and Coral Gardens had one piece of general rubbish.
- Hard coral damage was recorded at all except three sites. The highest abundance (15 counts) was recorded at Jetty Flat.
- Coral bleaching was recorded on 14 sites, but in relatively low levels. The highest population bleaching was recorded at Shark Bay (6.5% of the population; 12.25% of each colony on average). Harry's Bommie had the highest individual colony bleaching average (54.75%) with population bleaching levels of just 2.25%. Total average coral population bleaching across all sites was 2%, a decrease on previous records.
- Coral disease was recorded at 12 of the 17 sites. Of these, six had incidents of ten or less recorded. Coral Gardens again had the highest counts of disease, with 75 incidents recorded per 400m², an increase from 2019. Heron Bommie had the second highest count of coral disease, with 67 per 400m², also an increase from 2019. Average coral disease counts across all sites was 23.6 per 400m².
- Refer to Appendix A for comparative graphical representation of 2020 results for all survey locations.

3.0 INTRODUCTION

3.1 Reef Check Australia Overview

Trained Reef Check Australia (RCA) volunteers have been monitoring reef health around Australia since 2001. Annual surveys provide long-term data sets that can be used for local and regional reef management that can be compared to Reef Check data around the world. This temporal information can help reveal important patterns over time.

The Reef Check program is intended to supplement government and academic monitoring efforts, filling spatial and temporal gaps in reef monitoring. It also provides an opportunity for community members to play an active role in reef monitoring, education and conservation. Broad-scale reef data from Reef Check can act as an early warning system for changes in the health of coral habitats.

3.2 Reef Check Methodology

Reef Check uses a globally standardised protocol to collect data on 25 categories of substrate cover, as well as the abundance of 14 indicator invertebrates and 10 reef health impacts (Hill and Wilkinson, 2004). Reef Check surveys are conducted along a transect line marked by a graduated tape measure and laid at a constant depth. The transect length that is surveyed is 80 m, divided into four 20 m sections, each separated by 5 m (Figure 1a). This design allows for data comparisons within sites using the four independent replicates, as well as between sites.

The substrate survey collects information about the percentage cover of bottom-dwelling (benthic) organisms and substrate on the reef using a point-intercept method. A survey diver records the substrate type (Table 1) that is directly below the tape measure every 50 cm along each of the four 20 m sections interval (Figure 1b).

Invertebrate and impact surveys are conducted along the same transect line using a 5 m wide belt transect methodology. Divers search for indicator invertebrates and reef impacts on each 20 m replicate for 7 - 10 minutes using a u-shaped search pattern (Figure 1a). The 14 invertebrate indicators have been selected based on their economic and/or ecological importance. Reef health indicators include ten reef impacts, focusing on issues that may be addressed through management strategies. Similarly, fish surveys are conducted along a 5 m tunnel (Figure 1c).

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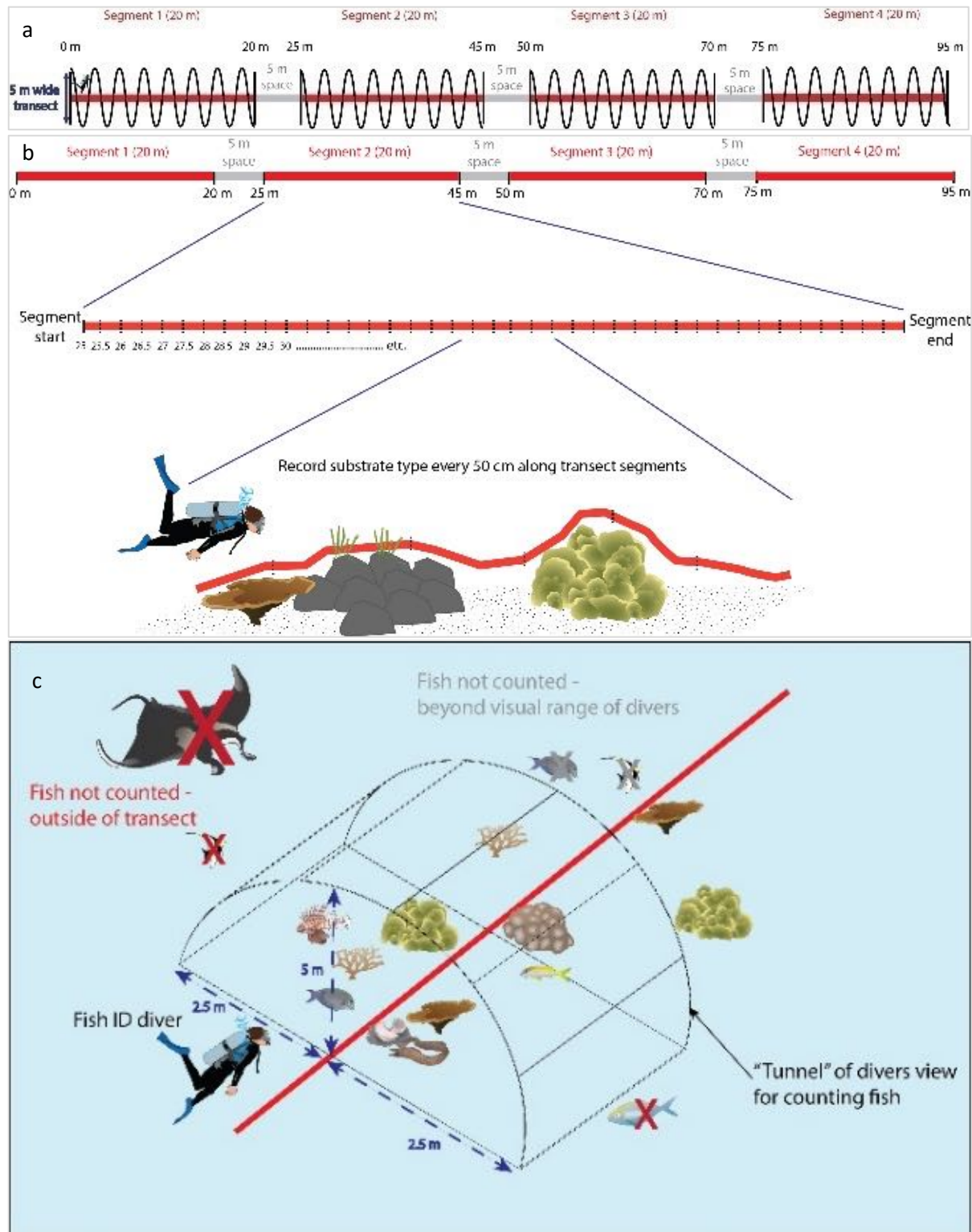


Figure 1: Reef Check survey methodology based on Hill and Wilkinson, 2004 showing (a) line intercept and belt survey transect layout consisting of 4 x 20 m replicates, (b) line intercept substrate survey protocol showing data collection points at 50 cm intervals, and (c) diagram of the belt transect tunnel for fish surveys (Image by Roelfsema et al, 2014).

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Table 1. Codes for Reef Check Australia substrate categories

Hard Coral	HCBR: Branching Hard Coral
	HCF: Foliose Hard Coral
	HCM: Massive Hard Coral
	HCE: Encrusting Hard Coral
	HCP: Plate Hard Coral
	HC: All other growth forms
	HCB: Bleached Hard Coral
Soft Coral	SCL: Leathery Soft Coral
	SCZ: Zooanthids
	SC: Other Soft Coral (ornate)
	SCB: Bleached Soft Coral
Recently Killed Coral	RKCTA: Recently killed coral with Turf Algae
	RKCNIA: Recently Killed Coral with Nutrient Indicator Algae
	RKC: Recently Killed Coral (bare)
Rock	RCTA: Rock covered with Turf Algae
	RCCA: Rock covered with Coralline Algae
	RC: Rock (not covered with algae)
Sponge	SPE: Encrusting Sponge
	SP: All other Sponges

There are a total of 17 sites at Heron Reef monitored by Reef Check Australia which were established to allow for a detailed representation of Heron Island reef habitats, and were selected to represent diverse management and use areas - six sites are located in protected Green zones, six are located in general use areas, and five are located in a scientific research zone (allows extraction for experimental and educational purposes). During the 2020 RCA surveys, all of these 17 sites were revisited.

Reef Check transects are co-located with UQ Remote Sensing Research Centre survey sites. At these survey sites, geo-referenced benthic photo transects (Roelfsema et al 2021) are conducted annually as part of a coral reef monitoring research project that started in 2001. The research project involves using the collected benthic field data in combination with high spatial resolution satellite imagery to create and validate benthic community maps of Heron Reef (e.g. Roelfsema et al 2013).

Additionally, CoralWatch Coral Health Chart surveys were collected at survey sites to specifically assess coral colour as an indicator of coral stress (Siebeck et al 2006). Similarly, REEFSearch surveys were also conducted at survey locations to ensure the use of a diverse array of data collection tools.

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3.3 Heron Island: Location and Demographics

Heron Island (0.62 km²) is a coral cay located on the southern section of the Great Barrier Reef, approximately 80 km off the coast of Gladstone, Queensland with a 27 km² platform reef. The surrounding waters are divided into one of three management designations, including Marine National Park (Green Zone), Conservation Park or Scientific Research zones (Figure 2).

Heron Island hosts the Heron Island Resort and the University of Queensland's Research Station (HIRS). Heron Island Resort is a popular location for scuba diving and snorkelling that accommodates up to 200 guests and 100 staff members. The HIRS is a heavily utilised research station with visiting universities, schools, and researchers from Australia and the world, accommodating up to 150 people. The fringing reefs are well-utilised for snorkel and dive tourism as well as reef research. However, these activities may be having some unintended impacts. Factors such as extensive development in the nearby Gladstone region, and similar to other coral reefs, global climate change, also pose threats to this marine ecosystem. Thus routine monitoring of this reef is essential. The 17 RCA survey sites are shown in Figure 2 and a summary of site demographics is represented in Table 2.

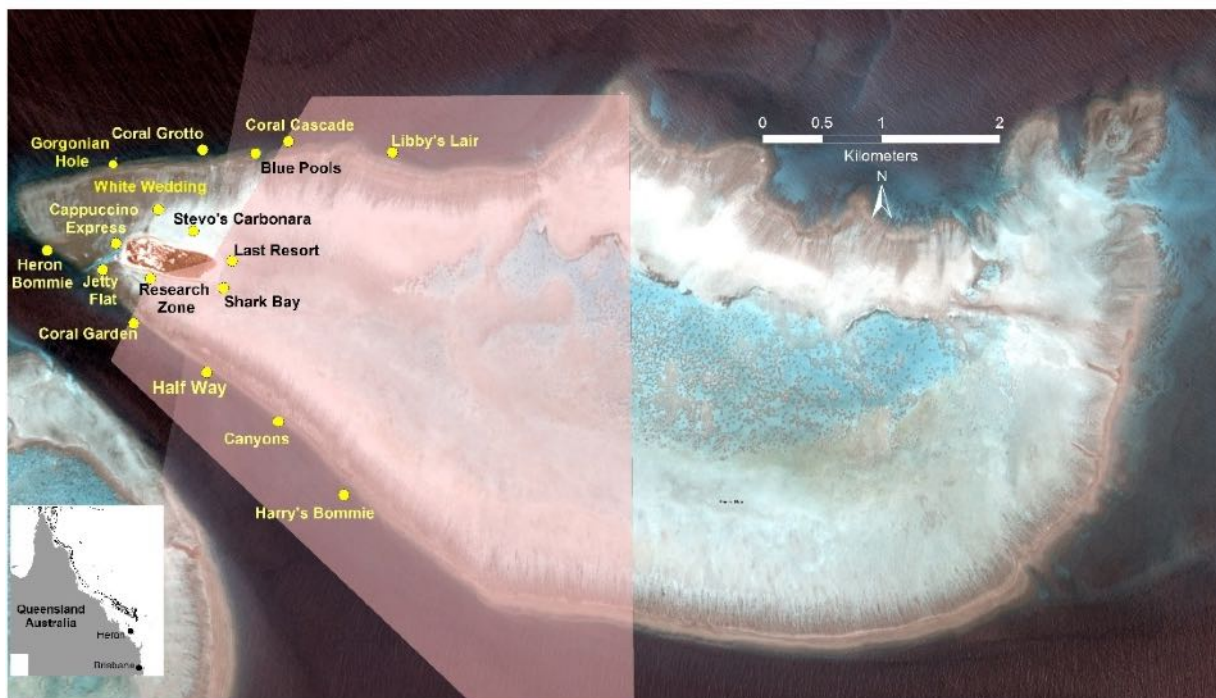


Figure 2. RCA field sites and the conservation zone overlaid on the Planet Dove image acquired on 9 November 2018 over Heron Reef, Southern Great Barrier Reef, Australia (Image source: Planet Ltd).

Table 2. RCA Heron Island monitoring locations, with depth, hard coral cover for the current survey year, designation of site (Marine National Park, Conservation Park, or Scientific Zone), habitat type and survey years.

Site	Depth (m)	HC %	Site Designation	Habitat Type	Year Surveyed									
					2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Blue Pools	5	79	Conservation Park	Reef Slope										
Canyons	5	76	Scientific Zone	Reef Slope										
Cappuccino Express	2	18	Marine National Park	Sandy reef flat with micro atolls										
Coral Cascade	6	60	Conservation Park	Reef Slope										
Coral Gardens	5	70	Marine National Park	Reef Slope										
Coral Grotto	6	61	Conservation Park	Reef Slope										
Gorgonian Hole	6	69	Conservation Park	Reef Slope										
Halfway	6	26	Scientific Zone	Reef Slope										
Harry's Bommie	9	65	Scientific Zone	Reef Slope										
Heron Bommie	5	61	Marine National Park	Reef Slope										
Jetty Flat	2	31	Marine National Park	Reef flat with micro atolls										
Last Resort	2	3	Conservation Park	Sandy reef flat										
Libby's Lair	6	72	Conservation Park	Reef Slope										
Research Zone	1	9	Scientific Zone	Sandy Reef Flat										
Shark Bay	2	11	Scientific Zone	Sandy reef flat										
Stevos Carbonara	2	0	Marine National Park	Sandy reef flat with micro atolls										
White Wedding	1	7	Marine National Park	Sandy reef flat										

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4.0 SUMMARY 2020 SURVEY REPORT

A summary of the findings for the 2020 RCA monitoring is shown in Table 3. Information includes: average hard coral cover (%), total macro algae abundance, abundance of invertebrates (collector urchin, sea cucumbers, giant clams, Triton, *Trochus*, *Drupella* snails, anemones), abundance of reef impacts (*Drupella* scars, unknown scars, coral damage, average coral bleaching of population percentage, average coral bleaching percentage for colony surface), and silt levels (N=none, L=low, M=medium, H=high). Categories are listed as abundance counts unless otherwise specified. The information represents data collected over a standard survey as described in section 3.2.

Table 3: Summarised RCA findings for Heron Reef survey sites in 2020.

Site	Substrate		Invertebrates								Impacts								
	Hard Coral Coverage (%)	Macro Algae (#)	Edible Sea Cucumbers (#)	Giant Clam (#)	Triton (#)	Trochus (#)	Drupella Snail (#)	Anemone (#)	Banded Coral Shrimp (#)	Crown of Thorns Starfish (#)	Drupella Scar (#)	Unknown Scar (#)	COTS Scar (#)	Coral Damage (#)	Coral Disease (#)	Coral Bleaching Population (%)	Coral Bleaching Colony (%)	Marine debris (#)	Silt Level*
Blue Pools	79.38	0	9	5	0	0	0	0	0	0	0	5	0	2	3	0.75	7.5	0	N
Canyons	76.25	0	0	9	0	0	4	0	0	0	2	8	0	4	15	0.50	4.5	2	N
Cappuccino Express	18.13	0	16	6	0	0	0	0	0	0	0	2	0	6	0	0	0	0	L
Coral Cascade	60	0	0	3	0	0	0	1	0	0	0	2	0	10	41	0.25	1	3	N
Coral Gardens	70	1	0	2	0	0	0	0	0	0	0	1	0	10	75	0.75	72.5	1	N
Coral Grotto	60.62	0	3	0	0	1	0	1	0	0	2	3	0	10	8	0	0	0	L
Gorgonian Hole	69.38	0	7	1	0	0	12	3	0	0	4	4	0	5	7	1	10	0	N
Halfway	26.25	0	0	3	0	2	2	0	0	0	0	4	0	0	16	3.75	8.75	0	N
Harry's Bommie	65	0	1	5	0	0	0	0	0	0	0	15	0	6	40	2.25	54.75	0	N
Heron Bommie	60.62	0	0	13	0	0	0	0	0	0	0	0	0	13	67	1	25	2	N
Jetty Flat	30.63	0	0	1	0	0	0	0	0	0	0	12	0	15	4	4.25	5	0	N
Last Resort	3.13	8	12	4	0	0	3	0	0	0	0	34	0	14	0	0.75	15.5	0	N
Libby's Lair	71.88	1	2	1	0	0	0	0	0	0	0	2	0	8	7	0	0	0	N
Research Zone	8.75	12	3	2	0	0	0	0	0	0	0	9	0	0	0	0.5	11.75	0	N
Shark Bay	10.63	33	33	2	0	0	12	0	0	0	1	1	0	0	0	6.5	12.25	0	N
Stevo's Carbonara	0	2	1	1	0	0	1	2	0	0	0	21	0	4	0	0	3.75	0	L
White Wedding	6.88	12	8	23	0	0	0	0	0	0	0	1	0	10	1	4.25	24	0	N

* N=none, L=low, M=medium, H=high

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To illustrate broad-spatial scale trends in the RCA data collected during the 2020 surveys, the data from each individual site was overlaid on ESRI image sourced through QGIS. Firstly, the percentage of hard coral coverage and bleaching incidence are depicted in Figure 3.



Figure 3. RCA hard coral cover and population level bleaching data for the 2020 surveys. Map created using QGIS software with an Esri basemap image acquired 19 December 2020.

For 2020, bleaching was recorded on 14 of the 17 sites. Slightly higher levels of coral population bleaching were recorded on the shallow inshore sites of Heron Island (average of 2%), however, higher average coral colony bleaching was detected on deeper reef slope offshore sites (average 18% compared to 10% for shallow reef flat inshore sites). The highest average population bleaching across a single site was Shark Bay with 6.5%.

Figure 4 shows the hard-coral data compared to the incidence of scars.

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Figure 4. RCA hard coral cover and scar data for the 2020 surveys. Map created using QGIS software with an Esri basemap image acquired 19 December 2020.

Instances of unknown scars were recorded at 16 of the 17 sites. Ten or more scars were recorded per 400m² for Harrys Bommie, Jetty Flat, Last Resort and Stevos Carbonara (15, 12, 34 and 21 respectively). Crown of Thorns Starfish (CoTS) scars were not observed on Drupella scars were only observed at four sites. The two highest levels of coral scars were recorded on the shallow sites (34 at Last Resort and 21 at Stevos Carbonara).

Figure 5 summarises the incidence of coral disease to hard coral cover recorded on the 2020 surveys.

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Figure 5. RCA hard coral cover and coral disease data for the 2020 surveys. Map created using QGIS software with an Esri basemap image acquired 19 December 2020.

Instances of coral disease were recorded on transect at 12 of the 17 sites. A greater proportion of coral disease was recorded at Coral Garden (75 counts), and Heron Bommie (67 counts), with 41 counts at Coral Cascades and 40 at Harrys Bommie. This is an increase on data recorded in 2019. Halfway (16 counts) and Canyons (15 counts) were the next highest, with other survey locations between 1 and 8 counts.

Shallow inshore, easily accessible sites had a much lower average of coral disease occurrence (only recorded on two sites) when compared to deeper, reef crest/slope sites accessible only by boat (average of 27 counts per 400m²).

Coral damage is summarised relative to the percentage of hard coral cover in Figure 6.

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Figure 6. RCA hard coral cover and coral damage data. Map created using QGIS software with an Esri basemap image acquired 19 December 2020.

Fourteen of the 17 sites had instances of coral damage. The average coral damage for all 14 sites was 6.9 counts per 400m². Higher than average counts of coral damage was recorded for Jetty Flat, Last Resort and Heron Bommie (15, 14, and 13 counts per 400m² respectively), whilst Coral Cascade, Coral Garden, Coral Grotto and White Wedding each had 10 instances. In contrast, no coral damage was recorded at Halfway, Research Zone or Shark Bay.

Invertebrate surveys record the abundance of indicator invertebrates along each transect. Figure 7 and Figure 8 show the abundance of giant clams and indicator sea cucumbers respectively, for each survey site.

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Figure 7. RCA Giant Clam abundance. Map created using QGIS software with an Esri basemap image acquired 19 December 2020.

The average distribution of giant clams was similar between inshore reef flat sites and deeper reef slope sites (5 and 4 counts per 400m² respectively). Heron Bommie (southern reef slope) and White Wedding (northern reef flat) had the highest recorded numbers of giant clams with 13 and 23 (respectively) found on transect. Coral Grotto was the only site with no giant clams recorded on transect.

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Figure 8. RCA abundance of sea cucumber. Map created using QGIS software with an Esri basemap image acquired 19 December 2020.

Target sea cucumbers were recorded at 11 of the 17 sites. The highest numbers of sea cucumbers were recorded on shallow near shore, sandy reef flat areas. The highest count of target sea cucumbers was at Shark Bay (33 per 400m²), followed by Cappuccino Express (16 per 400m²) and Last Resort (12 per 400m²). Only one of the shallow near shore sites (Jetty Flat) had zero target sea cucumbers.

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5.0 INDIVIDUAL SITE REPORTS

5.1 Blue Pools

Blue Pools is situated along the reef slope, on the northern side of Heron Island. This site is characterised by a series of shallow canyons cutting into the edge of the reef, with patches of rubble out deeper, away from these ridges (Images 1-2).

Hard coral represented 79% of the total substrate cover, an increase from 2014 and 2017 (Figure 9) and the highest hard coral cover recorded in 2020. Rock (including rock with turf algae and rock with calcareous algae) was the next greatest contributor to substrate at 14% cover. Sand attributed 4%.

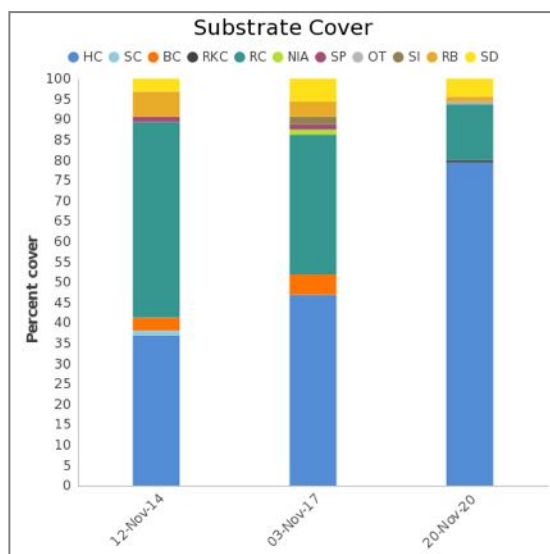


Figure 9. Benthic type and percent cover: Blue Pools, 2014 – 2020

Five giant clams and nine edible sea cucumbers were recorded on the invertebrate survey. One Triton shell was observed off transect (Image 3).

Bleaching affected less than 1% of the coral population, with an average of 7.5% of each coral colony affected.

Five incidents of unknown coral scars and two counts of coral damage were recorded.

A fish survey was conducted and two Barramundi Cod, 19 butterflyfish, 29 snapper, two grouper, six sweetlip and 17 parrotfish were recorded.



Image 1: Site Location – represented by circle



Image 2: Site Photo



Image 3: Triton Shell

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5.2 Canyons

Canyons is situated along the reef slope, on the southern side of Heron Island. This site is characterised by a series of shallow canyons cutting into the edge of the reef, with scattered bommies out deeper, away from these ridges (Image 4).

Hard coral represented 76% of the total substrate cover (Figure 10); one of the highest hard coral covers recorded in 2020. Rock (including rock with turf algae and rock with calcareous algae) was the next greatest contributor to substrate at 21% cover. Rubble and recently killed coral attributed 1% each.

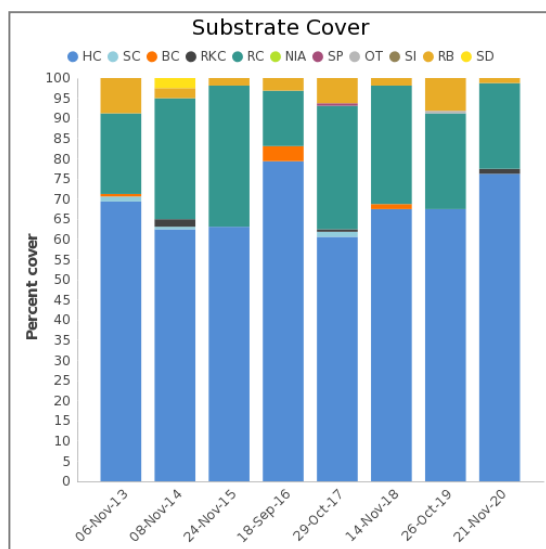


Figure 10. Benthic type and percent cover: Canyons, 2013 – 2020.

Nine giant clams (Image 5) and four *Drupella* snails were recorded on the invertebrate survey.

Bleaching affected less than 1% of the coral population, with an average of 4.5% of each coral colony affected (a decrease from previous years).

Fifteen incidents of coral disease (Image 6), four counts of coral damage, eight unknown scars and 2 *Drupella* scars were recorded, along with two pieces of trash.

A fish survey was conducted and 31 butterflyfish (an increase from last year), ten snapper and six parrotfish were recorded.

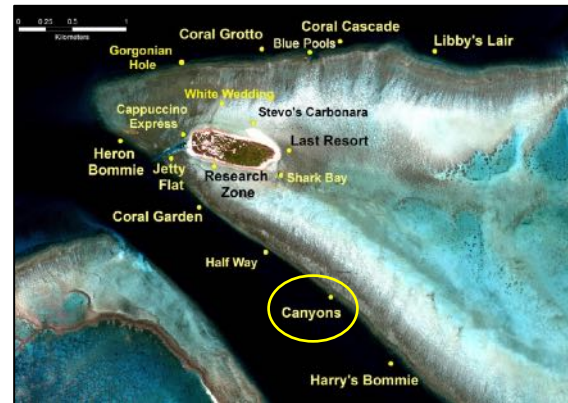


Image 4: Site Location – represented by circle



Image 5: Giant Clam

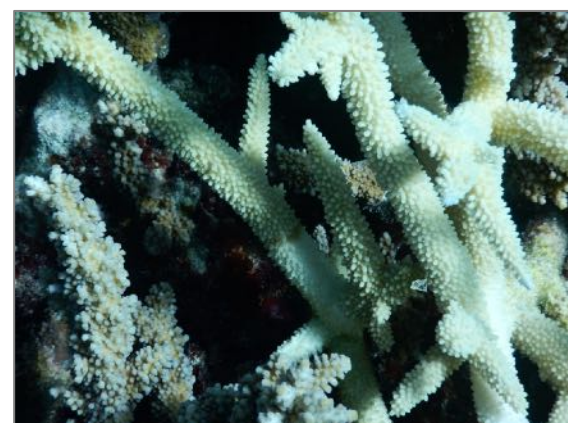


Image 6: Coral Disease

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5.3 Cappuccino Express

Cappuccino Express is on the reef flat. The site is characterised by small coral atolls and sandy patches and is prone to strong currents (Images 7-8). This reef area is easily accessible on snorkel and often visited by tourists as it is situated close to the resort.

Hard Coral represented 18% of the total substrate at this site (Figure 11) for 2020. Rock was the greatest contributor to substrate, making up 49%. Sand constituted 16% and rubble attributed 12%.

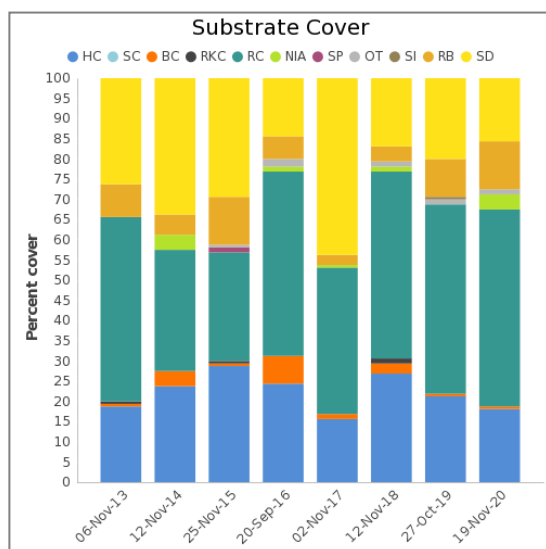


Figure 11. Benthic type and percent cover: Cappuccino Express, 2013 - 2020.

Six giant clams and 16 sea cucumbers (Image 8) were recorded on the invertebrate survey.

Coral bleaching was not observed at this site in 2020, which is a decrease from 2019, although coral cover remained similar.

Two incidents of unknown scars and six counts of coral damage was recorded.

A fish survey was conducted and one Barramundi Cod, one Moray eel, five snapper, six parrotfish, and ten butterflyfish were recorded.



Image 7: Site Location – represented by circle



Image 8: Prickly Greenfish; Target Sea Cucumber



Image 9: Turtle

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5.4 Coral Cascades

Coral Cascades is situated on the reef slope on the northern side of Heron Reef. Coral Cascades is a dive site often utilised by tourists and researchers alike. It is characterised by a high abundance of hard coral, hence the name (Images 10-11).

Hard coral cover represented 60% of the substrate at this site (Figure 12). Rock (including rock with turf algae and rock with coralline algae) constituted 28% of the substrate, soft coral; 6% and Sand 3%.

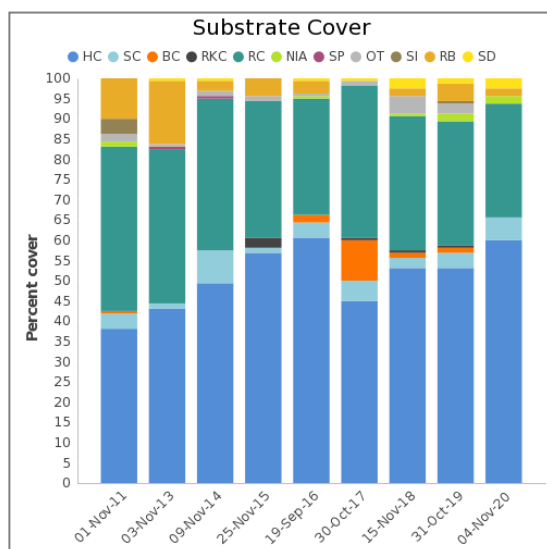


Figure 12. Benthic type and percent cover: Coral Cascades, 2011 - 2020.

One anemone and three giant clams were recorded on the invertebrate survey.

Bleaching was recorded on just 0.25% of the coral population, with an average 1% of each affected coral surface bleached, lower than previous years.

Other reef impacts recorded at this site included ten counts of coral damage, three pieces of marine debris, 41 counts of coral disease and two unknown scars.

A fish survey was conducted and nine parrotfish, 16 butterflyfish, four coral trout, and three snapper were recorded.



Image 10. Site Location – represented by circle



Image 11: Site Photo by Emma Kennedy



Image 12: Coral Disease; photo by Emma Kennedy

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5.5 Coral Gardens

Coral Gardens is located on the southern side of Heron Island on the reef slope. It is characterised by high hard coral cover; particularly branching growth forms (Image 13). It is a popular dive destination for the resort.

Hard coral accounted for 70% of the benthos at this site and was made up almost exclusively of branching coral growth forms (Image 14). Rock (including rock with turf algae and rock with calcareous algae) accounted for 23% rubble constituted 6% (an increase from 2019) and soft coral 1% of total substrate. One incidence of macro algae was recorded, the first at this site since 2011 (Figure 13).

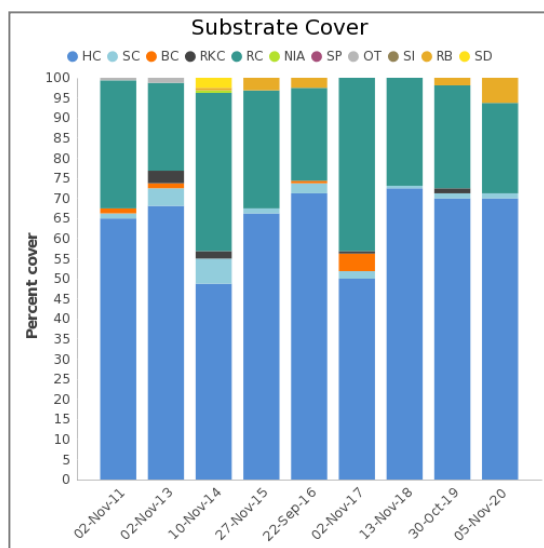


Figure 13. Substrate type and percent cover at Coral Gardens, 2011 - 2020.

Two Giant Clams were the only target invertebrates recorded on the invertebrate survey.

Bleaching was recorded on less than 1% of the coral population, but with an average of 72.5% of each affected coral surface bleached. However, this figure is represented by only 1 colony in each transect. Reef Impacts recorded at Coral Gardens include 75 incidences of coral disease, one unknown scar (Image 15), one of trash and ten of coral damage.

A fish survey was conducted and 17 butterflyfish, four parrotfish, three coral trout, six snapper, three grouper, and one sweetlip were recorded.



Image 13: Site Location – represented by circle



Image 14: Site Photo by Emma Kennedy



Image 15: Coral Scar; photo by Emma Kennedy

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5.6 Coral Grotto

Coral Grotto is located on the reef slope on the northern side of Heron Island. It is characterised by high hard coral cover. (Images 16-17).

Hard coral accounted for 61% of substrate (Figure 14). Rock constituted 24% of substrate cover, soft coral 6%, rubble 6%, sand 2.5% and 'other' (mostly Ascidians) 1%.

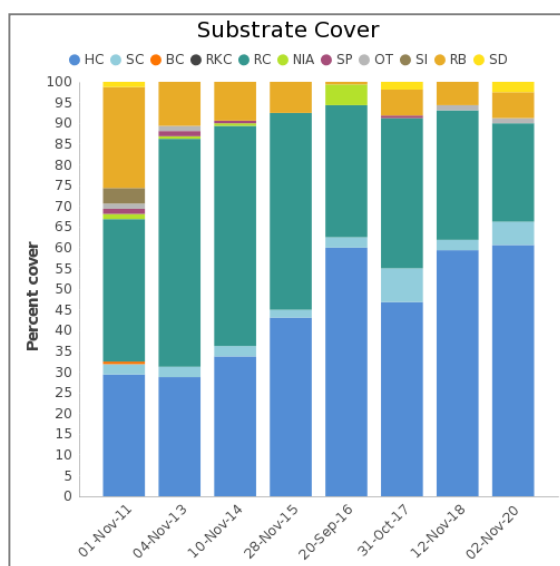


Figure 14: Benthic type and percent cover: Coral Grotto, 2011 - 2020.

Three sea cucumbers, one anemone and one trochus were recorded for the invertebrate survey, with a lobster observed off transect (Image 18).

Coral bleaching was not observed but two *Drupella* scars, three unknown scars, ten incidences of coral damage and eight of coral disease were recorded.

A fish survey was conducted and 27 butterfly fish, one coral trout and 34 snapper were recorded, which is higher than previous years.



Image 16. Site Location – represented by circle



Image 17. Site Photo by Emma Kennedy



Image 18: Lobster; photo by Emma Kennedy

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5.7 Gorgonian Hole

Gorgonian Hole is located on the reef slope on the northern side of Heron Island. It is characterised by high hard coral cover, particularly branching growth forms (Images 19-20).

Hard coral accounted for 69% of substrate (Figure 15). Rock constituted 27% of substrate cover, and rubble 1%, with soft coral, other and sand at less than 1% each.

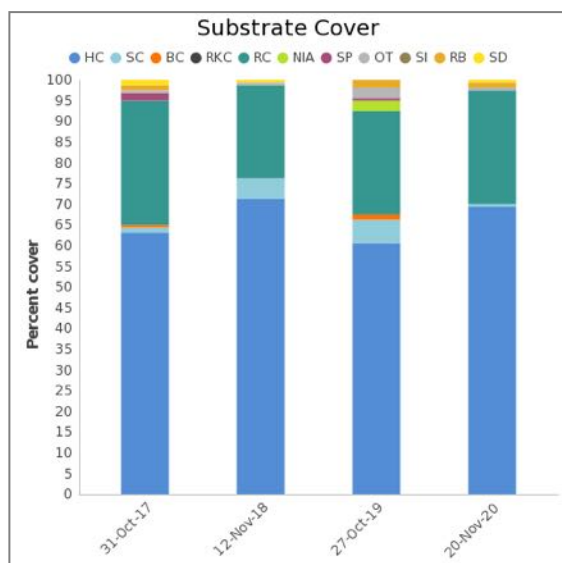


Figure 15: Benthic type and percent cover: Gorgonian Hole, 2017 - 2020.

Seven sea cucumbers, three anemone and one giant clam and 12 *Drupella* snails were recorded for the invertebrate survey.

Coral bleaching was estimated to affect 1% of the total coral population and an average of 10% of each colony surface.

Additional impacts recorded include four *Drupella* scars (Image 21), four unknown scars, five counts of coral damage and seven counts of coral disease.

A fish survey was conducted and 17 butterfly fish, 33 parrotfish, ten snapper, two coral trout and three grouper were recorded. A

Barramundi Cod was also recorded off transect.



Image 19. Site Location – represented by circle



Image 20. Site Photo

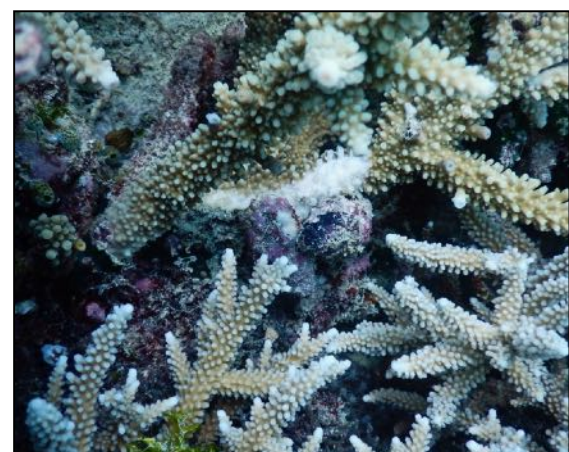


Image 21: *Drupella* and Scar

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5.8 Half Way

Half Way is located on the southern side of Heron Island, on the reef slope, halfway between Canyons and Coral Garden (Image 22). It is characterised by hard coral cover, (Image 23), but was observed to have a large amount of historically damaged coral.

Rock (rock with turf algae and rock with calcareous algae, which includes dead coral with algae) accounted for 62% of the total substrate. Hard coral cover at this site accounted for 26% of substrate cover, soft coral 7.5%, rubble 2% and sand and sponge just over 1% each (Figure 16).

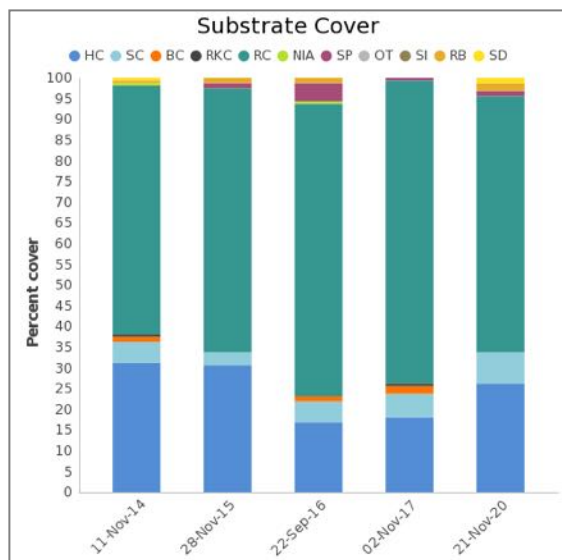


Figure 16. Benthic type and percent cover: Half Way, 2014 - 2020.

Three giant clams, two *Trochus* (Image 24) and two *Drupella* snails were recorded during the invertebrate survey.

Coral bleaching affected approximately 4% of the total coral population, with an average of 9% of each colony showing surface bleaching.

Four incidents of unknown coral scars and 16 incidents of disease were recorded on the impact survey.

A fish survey was conducted and 15 butterflyfish, one moray eel, eight parrotfish,

11 bumphead parrotfish and two snapper were recorded. A coral trout and a barramundi cod were also observed off-transect.



Image 22. Site Location – represented by circle



Image 23. Site photo

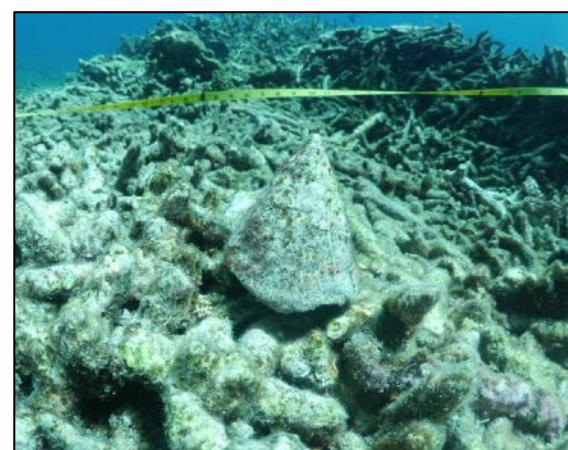


Image 24. *Trochus* shell

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5.9 Harry's Bommie

Harry's Bommie is located on the southern side of Heron Island, on the reef slope. It is characterised by large coral bommies and high hard coral cover, particularly branching growth forms (Image 25).

Hard coral cover at this site accounted for 65% of substrate cover (consistent with 2019) (Image 26), consisting predominantly of branching coral. Rock (rock with turf algae and rock with calcareous algae) accounted for 32.5% of the total substrate, with soft coral attributing just over 1% and bleached coral and sand making up <1% each (Figure 17).

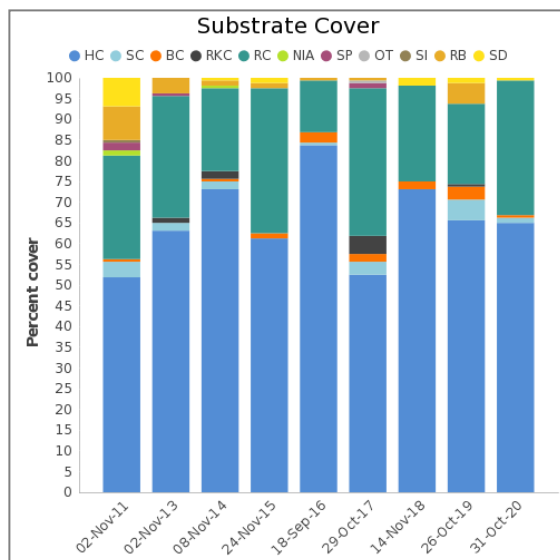


Figure 17. Benthic type and percent cover: Harry's Bommie, 2011 - 2020.

Five giant clams and one target sea cucumber were recorded during the invertebrate survey.

Coral bleaching affected approximately 2% of the total coral population, with an average of 55% of each colony showing surface bleaching (similar to 2018 and 2019 levels).

Coral disease (Image 27) ranked as the highest impact at 40 counts. Coral scars numbered 15 and there were six incidents of coral damage recorded on the impact survey.

A fish survey was conducted and three parrotfish, ten butterflyfish, four snapper and one each of coral trout, grouper and sweetlips were recorded.



Image 25. Site Location – represented by circle



Image 26. Transect photo by Emma Kennedy



Image 27. Coral disease; by Emma Kennedy

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5.10 Heron Bommie

Heron Bommie is located on the south west of Heron Island fringing reef slope (Image 27). It is characterised by a large coral bommie and high hard coral cover, particularly branching growth forms. Heron Bommie is a popular dive site with the resort due to its close proximity and high coral cover.

Hard coral represented 61% of the substrate (Figure 18) (an increase from 2019). Rock (including rock with turf algae and rock with calcareous algae) constituted 29% of substrate cover. Rubble attributed 4%, soft coral 4% and sand 2%.

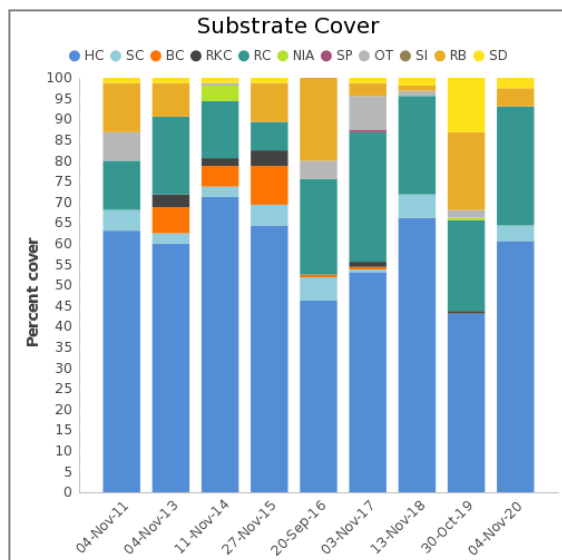


Figure 18. Benthic type and percent cover: Heron Bommie, 2011- 2020.

Thirteen giant clams (Image 21), and no other invertebrates were recorded on the invertebrate survey.

Coral bleaching affected approximately 1% of the total coral population, with an average of 25% of each colony showing surface bleaching.

Coral disease increased from 2019, with 67 counts recorded and 13 incidents of coral damage. Also recorded were two items of marine debris (research items).

A fish survey was conducted and three snapper, 16 butterflyfish, 16 parrotfish, eight coral trout, four grouper, one moray eel, and one bumphead parrotfish were recorded.

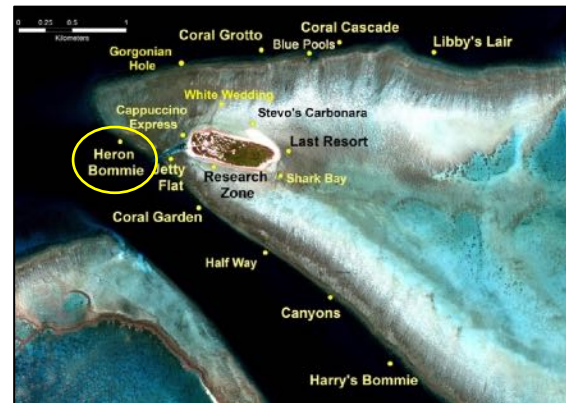


Image 28. Site Location – represented by circle



Image 29. Site Photo by Emma Kennedy



Image 30. Research tag: by Emma Kennedy

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5.11 Jetty Flat

Jetty flat is located on the south-western side of Heron Island, on the southeast reef flat near the boat channel. It is a shallow site often visited by snorkelers due to its location and ease of access. It is characterised by large areas of branching corals with flat, eroded tips (due to tidal extremes) and sandy patches (Images 22-24).

Hard corals accounted for 31% of the benthos (Figure 19). Rock (including rock, rock with turf algae and rock with calcareous algae) constituted 59% of the substrate, recently killed coral made up 9% and bleached coral <1%.

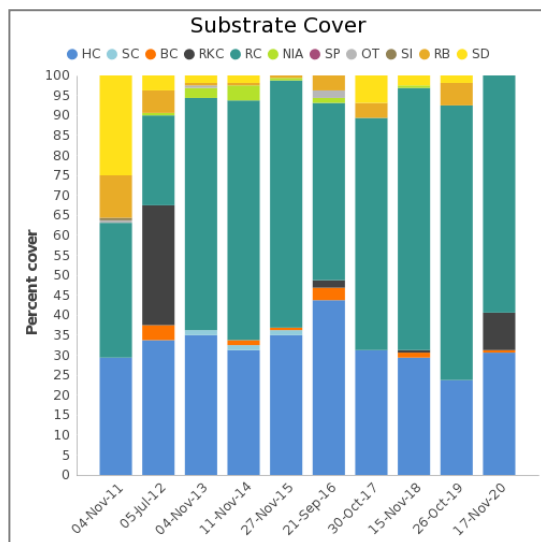


Figure 19. Benthic type and percent cover: Jetty Flat, 2011 - 2020.

Only one giant clam was recorded on the invertebrate survey.

Coral bleaching affected approximately 4% of the total coral population, with an average of 5% of each colony showing surface bleaching, a decrease from 2019.

Reef impacts recorded included 12 counts of unknown scars, 15 of coral damage and four of coral disease.

A fish survey was conducted and nine butterflyfish, two parrotfish and three snapper were recorded. Numerous rays were observed off-transect.



Image 31. Site Location – represented by circle

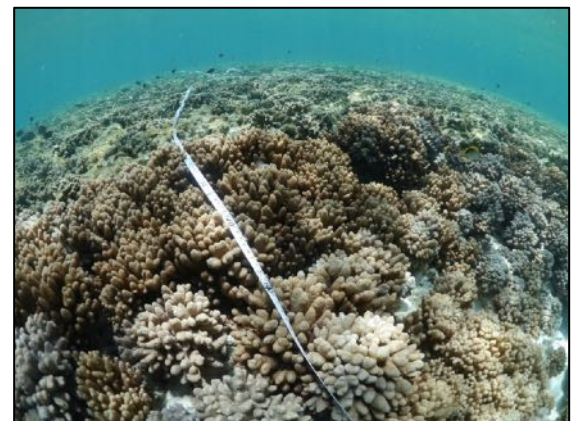


Image 32. Site Photo



Image 33. Surveyor with ray.

5.12 Last Resort

Last Resort is a lagoonal site accessible on snorkel, located at the north-east corner of the island (Image 34). It is frequented by tourists as it is a popular spot for shark and ray sightings.

Hard corals accounted for 3% of the benthos (Figure 20). Rock (including rock with turf algae and rock with calcareous algae) constituted 31% of the substrate, whilst sand contributed 40% (Image 35). Nutrient indicator algae attributed 17%, recently killed coral 2% and rubble accounted for 4%. Eight counts of macro algae were recorded (Image 36).

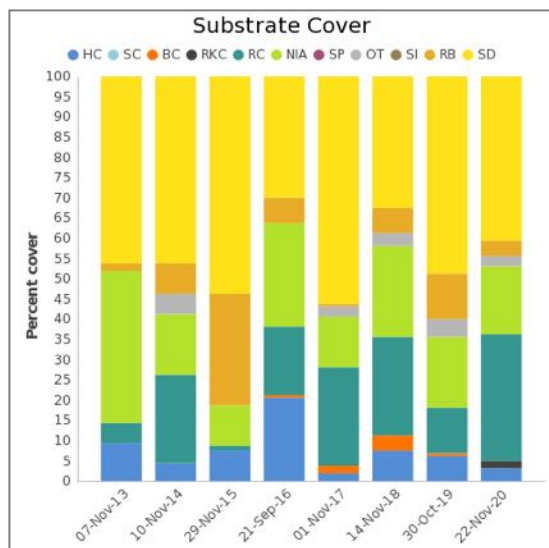


Figure 20. Benthic type and percent cover: Last Resort, 2013 - 2020.

Twelve sea cucumbers, three *Drupella* snails and four giant clams, were recorded on the invertebrate survey.

Coral bleaching affected <1% of the coral population and an average of 15% of each coral surface affected.

Fourteen counts of coral damage and 34 incidents of unknown scars were recorded, which is an increase on 2019

A fish survey was conducted and five snapper and three butterflyfish were recorded.



Image 34. Site Location – represented by circle



Image 35. Site Photo



Image 36. Dominant algae – *Padina* spp.

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5.13 Libby's Lair

Libby's Lair is located on the northern side of Heron Island, on the north east reef slope. It is characterised by high coral diversity and deep gullies (Image 37).

Hard coral accounted for 72% of the benthos, (Figure 21, Image 38). Rock (encompassing both rock with turf algae and rock with coralline algae) made up 18% of the substrate, with soft coral 4%, sand 4% and rubble at 3%.

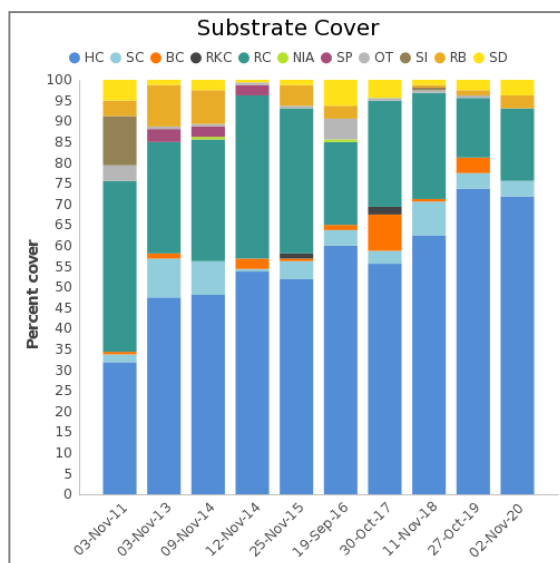


Figure 21: Benthic type and percent cover: Libby's Lair, 2011 - 2020.

One giant clam and two sea cucumbers were recorded on the invertebrate survey.

Coral bleaching was not recorded. Impacts recorded included eight incidents of coral damage, seven incidents of coral disease (Image 39), and two unknown scars.

A fish survey was conducted and 34 butterflyfish, one coral trout and seven snapper were recorded.



Image 37. Site Location – represented by circle



Image 38. Site Photo by Emma Kennedy

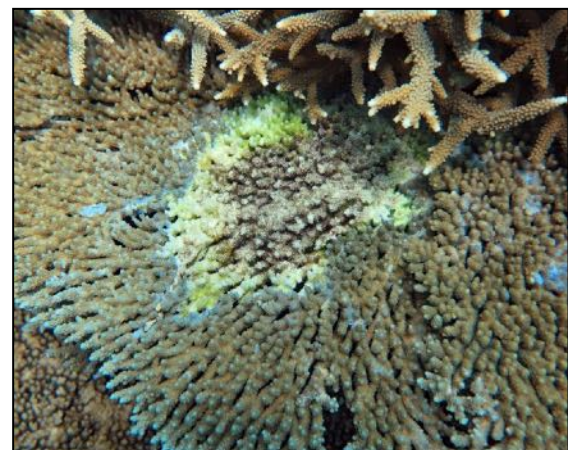


Image 39. Coral disease by Emma Kennedy

5.14 Research Zone

The Research Zone site is located on the southern side of Heron Island, within the scientific zone (Image 40). This area is designated for the harvesting of samples for scientific and educational purposes. It is a shallow site utilised by both researchers and tourists on snorkel due to its accessibility.

The majority of the substrate at this site is rubble (35%), with hard coral constituting 9% of the benthos (Figure 22). Rock (including rock with turf algae and rock with coralline algae) contributed 31% of the substrate. Sand attributed 9% and nutrient indicator algae attributed just over 1% to the benthos. Twelve counts of macro algae (*Padina*) were recorded.

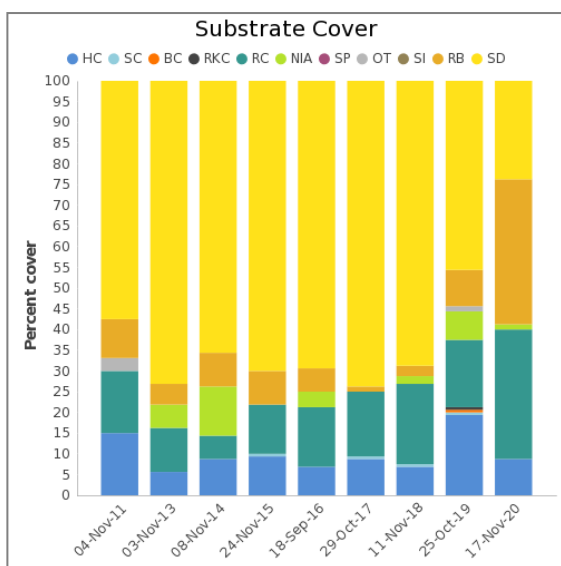


Figure 22. Benthic type and percent cover: Research Zone 2011 - 2020.

Three sea cucumbers and two giant clams were recorded on the invertebrate survey.

Coral bleaching affected 0.5% of the coral population with an average of 12% of each affected coral; similar to 2019.

Nine unknown scars were recorded on the impact survey.

A fish survey was conducted and four snapper, four butterflyfish and one parrotfish was recorded. We also observed two blacktip reef sharks off transect.

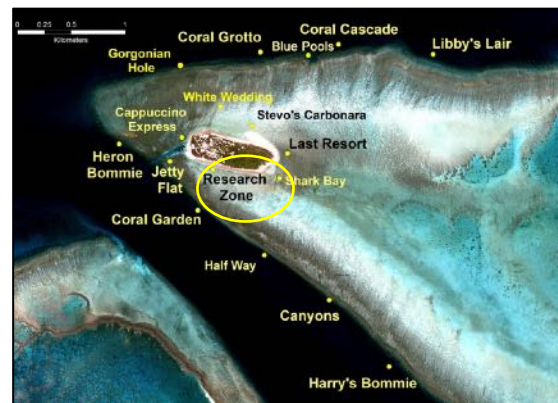


Image 40. Site Location – represented by circle



Image 41. Site photo



Image 42. Unknown scar

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5.15 Shark Bay

The Shark Bay site is located on the eastern side of Heron Island. It is a shallow site frequented by tourists on snorkel due to its accessibility, and shallow depth. This reef area is a popular spot for shark and ray sightings (Image 43).

Hard coral accounted for 11% of the benthos at this sandy (51%) reef flat location (Figure 23). Rock (including rock with turf algae and rock with calcareous algae) attributed 33%, recently killed coral was just over 1%, rubble <1% and other 3%. Nutrient indicator algae was not recorded (down from 29% in 2019), however thirty three counts of macro algae were recorded (Image 44).

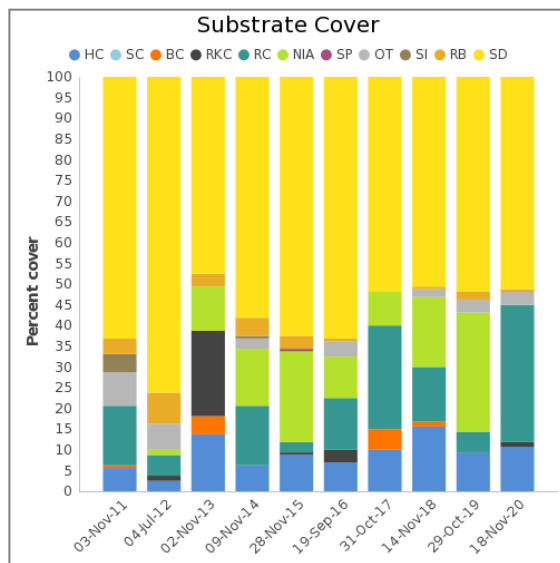


Figure 23. Benthic type and percent cover: Shark Bay, 2011- 2020.

Thirty-three sea cucumbers (the highest count for 2020), two giant clams and 12 Drupella snails were recorded during the invertebrate survey.

Coral bleaching affected 7% of the coral population, and an average of 12% of each affected colony.

One unknown coral scar and one Drupella scar (image 45) were recorded on the impacts survey.

A fish survey was conducted and nine butterflyfish, eight snapper and six parrotfish were recorded.

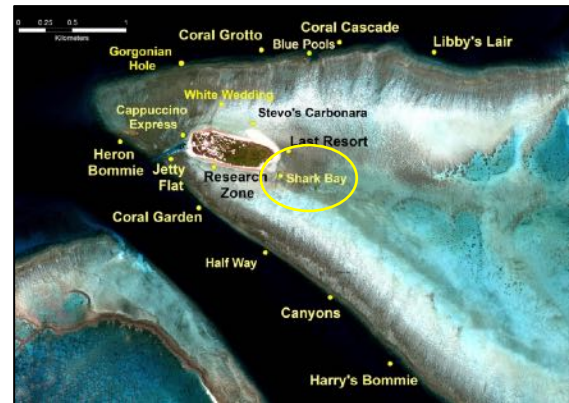


Image 43. Site Location – represented by circle



Image 44: Site Photo



Image 45: Drupella snails and Scar

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5.16 Stevo's Carbonara

Stevo's Carbonara is located on the reef flat on the northern side of the island (Image 46). It is close to the resort and regularly frequented by tourists on snorkel and also reef walkers.

Hard coral was not recorded on substrate transect in 2020 (Figure 24). Sand constituted 89% of the substrate (Image 47), nutrient indicator algae attributed 4%, other (mostly *Halimeda*), rubble and rock made up just under 2% each. Recently killed coral and silt were <1% each. Two counts of macro algae was recorded on transect.

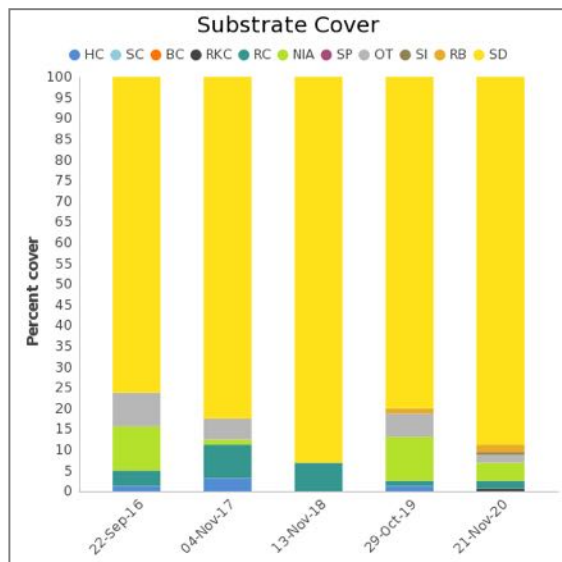


Figure 24. Benthic type and percent cover: Stevo's Carbonara, 2016 - 2020.

One sea cucumber, one giant clam, 1 *Drupella* snail and two anemones (with fish) Image 48) were recorded on the invertebrate survey.

On the impacts survey, coral bleaching was recorded as affecting 1% of the coral population, and an average of 4% of the surface of coral colonies (a decrease from 2019). Additionally, four counts of coral damage and 21 unknown scars were recorded.

A fish survey was conducted and one snapper was recorded.



Image 46. Site Location – represented by circle



Image 47: Site photo

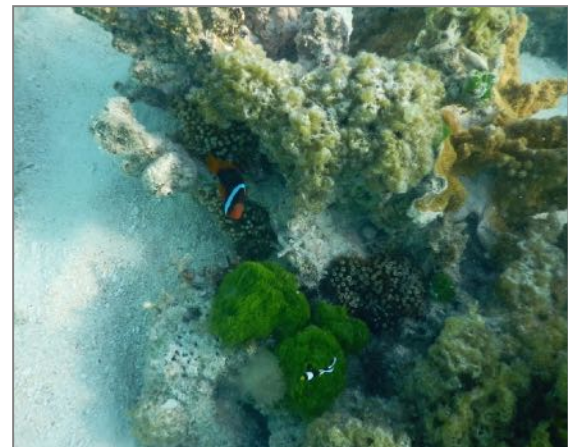


Image 48: Anemones with fish

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5.17 White Wedding

White Wedding is located on the reef flat on the northern side of the island (Image 49). It is close to the resort and regularly frequented by tourists on snorkel and also reef walking.

Hard coral accounted for 7% of the benthic substrate (Figure 25). Rock (consisting of rock, rock with turf algae and rock with calcareous algae) made up 46% and sand 42%. Rubble attributed 3% and other just under 2%. Twelve counts of macro algae were recorded.

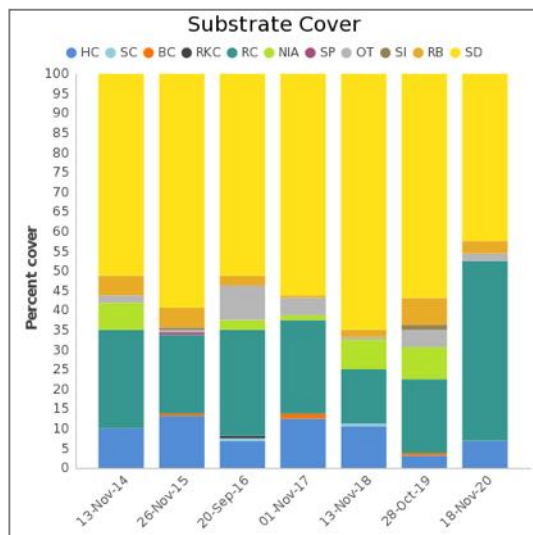


Figure 25. Benthic type and percent cover: White Wedding 2014-2020.

Twenty-three giant clams (up from 15 in 2019), and eight sea cucumbers were recorded on the invertebrate survey. Several large *Aplysia argus*, an algae grazing heterobranch were also observed at this site.

Coral Bleaching affected 4% of the coral population and an average of 24% of the surface of affected coral colonies.

One unknown scar, ten counts of Coral damage and one of coral disease were recorded on the impact survey.

A fish survey was conducted and two butterflyfish and 16 parrotfish were recorded.



Image 49. Site Location – represented by circle



Image 50: Site photo



Image 51: *Aplysia argus* (Black tailed sea hare)

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6.0 FURTHER INFORMATION

For more information on Reef Check Australia, survey methods, sites and previous reports, please go to www.reefcheckaustralia.org.

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Image 52: Reef scene at Blue pools

APPENDIX A COMPARATIVE ISLAND WIDE GRAPHS FOR 2020 DATA

